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**(57) Abstract:** A filter assembly is described that includes a substantially recyclable filter cartridge inside a pressure vessel. The invented filter cartridge comprises substantially non-pressure bearing walls, except for a pressure-bearing neck that is adapted to withstand high pressures preferably in the range of about 500 psi from the inside. The walls of the filter cartridge that are incapable of withstanding significant internal pressure are surrounded on the outside by a pressure vessel. The invented cartridge need not seal to the pressure vessel, because the cartridge neck protrudes outside of the pressure vessel to seal directly to a filter head. The cartridge preferably includes a quick-disassembly mechanism for allowing quick and non-destructive access to the internal components and media of the cartridge.



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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## Recyclable Filter Cartridge and Pressure Vessel

### DESCRIPTION

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#### BACKGROUND OF THE INVENTION

##### Field of the Invention.

The present invention generally relates to filter cartridges for water or beverages, such as those used in water, ice-water, soda pop machines, or other beverage dispensers. Specifically, the invention is a filter assembly, for cooperation with a filter head/manifold, that includes a filter cartridge substantially comprising recyclable components. More specifically, the invention relates to a filter assembly that allows all or substantially all of the surfaces that contact liquid to be periodically removed and recycled, thereby reducing the chance of contamination from long-term use of the surfaces. The filter cartridge is substantially non-pressure bearing, except for the neck of the filter cartridge that extends to form a liquid seal with the head/manifold. A pressure vessel substantially surrounds the filter cartridge for holding and supporting the walls of the filter cartridge under liquid pressure, but the pressure vessel does not necessarily liquid-seal to the filter cartridge or the filter head/manifold.

20

##### Related Art.

Many filter systems for water or other liquid filtration comprise a filter that cooperates with a "filter head," which term herein includes a fluid manifold, valve head, or

other connection device that directs fluid to and from the filter. The filter typically seals to an internal surface of the filter head so that the liquid entering the filter head flows into the filter, through the filter, then out of the filter to an outlet port in the filter head. In the United States and Canada, water filters are typically required to contain and withstand pressures of about 500 psi without rupturing. In the United States, water systems typically operate in the range of 40 - 125 psi, and NSF (National Sanitation Foundation) approval ratings typically require a water filter to withstand 4 times the claimed maximum operating pressure, or typically 500 psi. In Canada, safety factors require that water filters withstand about 508 psi for one minute.

In one general type of filter system, a disposable pressure vessel connects directly to a filter head. In such a system, when the filter media inside the pressure vessel is spent, the entire pressure vessel must be discarded, including the media contained therein. Disposable pressure vessels are not easily recyclable as there are no easy means to disassemble the pressure vessel. The disposable pressure vessel outer wall is entirely pressure-bearing, that is, it may safely withstand the liquid pressure of the particular system with a large safety margin. Therefore, disposable pressure vessels are more costly to replace because they use more plastic or more expensive materials such as aluminum. Use of disposable pressure vessels is, therefore, costly in terms of filter expense and environmental impact.

In alternative filter systems, a disposable filter cartridge may be supplied inside a pressure-bearing housing that connects to the filter head. In such a system, the pressure-bearing housing typically seals to the head using o-rings or other seals and surfaces that are contacted by the liquid being filtered. When the media of the filter cartridge is spent, the filter cartridge is typically discarded and replaced with another cartridge. The conventional

filter cartridge has few recyclable components, and, the few recyclable components of the cartridge, such as granular carbon contained in the cartridge, are not removable or easily accessible to a person who might want to recycle. While the filter cartridge is removed and thrown away, the thick-walled pressure vessel is reused. During use, portions of the pressure vessel come in contact with the liquid being filtered, and, therefore, the pressure vessel may become contaminated with bacteria or other unhealthy substances. Because the pressure vessel is continually reused, the contaminated portions remain in use in the filter system and can further the contamination problem in the filter system and in the liquid flowing through it.

Therefore, there is a need for an improved filter cartridge, which is substantially recyclable and which, therefore, reduces the resource and environmental created by the filter cartridge. Also, there is a need for an economical and efficient filter cartridge that is designed so that every time the filter cartridge is removed for recycling, the surfaces with the highest chance of being contaminated are also replaced. The filter assembly of the present invention fulfills these needs.

#### SUMMARY OF THE INVENTION

The present invention comprises a filter assembly featuring a substantially recyclable filter cartridge. The preferred cartridge includes substantially all components which are recyclable: a cartridge body, cartridge cap, media, media-support and containment pads, and center stem/tubes. The cartridge preferably, but not necessarily, includes an invented mechanism or "latch" for disassembly of the components of the filter cartridge so that the components may be separated and sent to appropriate recycling processes.

The invented filter assembly preferably, but not necessarily, includes a pressure-bearing “pressure vessel” that substantially surrounds the filter cartridge except for the protruding neck of the filter cartridge. The pressure vessel comes in close contact with the filter cartridge to safely support and reinforce the non-pressure-bearing filter cartridge, but  
5 does not necessarily seal to the cartridge. The filter cartridge neck is pressure-bearing and protrudes out from the pressure vessel to liquid-seal directly to the filter head, so that the entire outer surface of the filter cartridge is dry, that is, not contacted by liquid during filtration, and the entire outward pressure of liquid relative to the atmosphere is directed against the interior walls of the filter cartridge. This liquid pressure is contained inside the  
10 filter cartridge neck without reinforcement, while the liquid pressure is contained inside the filter cartridge body by virtue of the surrounding pressure vessel reinforcing the filter cartridge body wall. This is preferably accomplished by a thin-walled filter cartridge body with the neck wall being significantly thicker than the body wall, which results in excellent pressure containment and NSF Safety Factors with a much-reduced amount of total plastic to  
15 be recycled after use.

Objects of the present invention, therefore, include providing a recyclable filter cartridge for water and beverage filtration, herein including filtering, treatment, or other processing. An object is to provide such a recyclable filter cartridge that greatly reduces the environmental impact of the plastics and other materials used in the filter cartridge, and that  
20 is easily disassembled for separation of the various components for proper recycling. A further object is to make the filter cartridge recyclable while minimize the total amount of plastic that must be dealt with in the recycling process. This minimization of total recycled plastic is preferably done by providing a thin filter cartridge outer wall except for the relatively small pressure-bearing neck. Another object is to provide a filter cartridge system

in which all or substantially all of the surfaces that liquid contacts after leaving the filter head and prior to returning to the filter head are removed from the system when the filter cartridge is removed for recycling. Thus, the liquid-contact surfaces are filter cartridge surfaces rather than pressure vessel surfaces, and are replaced each time the filter cartridge is replaced.

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### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a top perspective view of one embodiment of the invented filter assembly.

Figure 2 is a top view of the filter assembly of Figure 1.

Figure 3 is a cross-sectional view of the filter assembly of Figures 1 and 2, viewed  
10 along the line 3-3 in Figure 2, with a dust cap installed.

Figure 4 is an enlarged detail cross-sectional side view of the top end of the filter assembly, which is the end circled in Figure 3.

Figure 5 is an exploded side perspective view of the pressure vessel, which comprises a pressure body and pressure cap of the filter assembly of Figures 1-4.

15 Figure 6 is an exploded side perspective view of the filter materials, media supports and filter pads, of Figures 1-4.

Figure 7 is an exploded side perspective view of the central stem, optional liquid bypass sleeve and o-rings, of the cartridge of Figures 1-4.

Figure 8 is an exploded side perspective view of the cartridge body, cartridge cap including inlet tube member in the cap, sealing members, and dust cap of the embodiment of  
20 Figures 1-4.

Figure 9 is a close-up perspective view of the exterior of the embodiment of a cartridge cap installed in a pressure vessel cap, according to the invention, with neck protruding through and up from an opening in the pressure vessel cap.



Figure 10 is a perspective view of the pressure vessel cap of the embodiment of Figure 10.

Figure 11 is a perspective view of filter cartridge cap of Figure 9, shown separate from the pressure vessel cap.

5        Figure 12 is an exploded perspective view of the cartridge body and cartridge cap of Figures 3 and 8, separated to illustrate one embodiment of a tab and slot connection system for snapping the body and cap together.

Figure 13 is a perspective view of the top end of the filter cartridge of Figures 3, 8, and 12, illustrating the cartridge cap snapped into the cartridge body.

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#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the Figures, there is shown one embodiment, but not the only embodiment, of the invented filter assembly 20 which includes filter cartridge 30 inside pressure vessel 22. The invented assembly 20 comprises a pressure vessel 22 which is  
15        visible as substantially the exterior surface of the assembly, and which has an aperture 24 through which the neck 44 of the filter cartridge 30 extends to seal directly to a filter head. The invented assembly 20 may be adapted for being secured to the filter head by several different ways, for example, the preferred bayonet mount 32 on the pressure cap 46, a threaded mount, or other connection means. Preferably, the invented pressure vessel  
20        mechanically connects to the filter head, by such a connection means, but does not fluidly connect, that is, it does not fluidly seal, to the filter head. The filter assembly of the invention may be adapted to cooperate with various filter heads, by adapting the connection means and the size and shape of the neck, which preferably comprise the filter cartridge liquid inlet and outlet passages. The preferred embodiment of the filter assembly 20 shown in the drawings

may cooperate with a filter head such as the type illustrated by the systems in U.S. Patents No. 4,857,189 and Design 356,625, and, once the disclosure of the present invention is viewed, one of skill in the art will be able to construct a filter head that will operatively connect with the invented filter cartridge. The cartridges conventionally built for such systems as shown in U.S. Patents No. 4,857,189 and Design 356,625 are of the type described in Related Art as a non-recyclable filter with its outer wall being entirely pressure-bearing.

In the preferred embodiment, fluid flows via the filter head into the central axial passage 134 in the filter cartridge 30 via an inlet end 33 of inlet tube member 34 out the bottom of the central axial passage, up through the filter media 36 (which may comprise one or more media, empty spaces, pads, supports, etc), and out of the filter cartridge 30 through a concentric annular passage 38 around the inlet tube member 34. In the preferred embodiment, shown to particular advantage in Figure 3, there are three different media in series 136, 137, 138, but other arrangements may be used. The filter cartridge may optionally include a liquid bypass system 35 for allowing some liquid flowing down the inlet tube member 34 to exit the central axial passage 134 part way down the tube to flow directly to, for example, the top bed 138 of media rather than flowing through all three beds of media. The liquid bypass system 35 may include one or more holes of a diameter sized to let a particular amount of liquid bypass the lower media, or may be other systems. The liquid bypass system 35 design is optional and is not required for the invented apparatus or practicing the invented filtration methods.

The filter cartridge 30 extends up through a central opening (aperture 24) in the pressure cap 46 and seals to the filter head (not shown) at two locations, at o-ring 42' (shown in Figures 3 and 8, in groove 42) and at a small diameter o-ring 52' (shown in Figures 3 and

8, in groove 52). This way, the neck provides and holds both seals necessary to fluidly connect the filter cartridge to the head using the concentric, annular inlet and outlet system of the filter cartridge. That is, as the preferred embodiment is arranged, the inlet to the filter cartridge is sealed at seal location 52 and the outlet of the filter cartridge is sealed between o-rings 42' and 52'.

The pressure vessel 22 comprises a pressure body 54, which is a generally cylindrical member with a closed end and an open end, and a pressure cap 46 that connects to the pressure body across its open end. The connection may be a threaded connection, as shown in the drawings, but may be other designs. The pressure body 54 preferably has axial exterior ribs 56 for strengthening the body. The pressure cap 46 has top aperture 24 centered along the central longitudinal axis of the pressure vessel 22 for receiving the protruding neck 44 to an extent that allows the filter cartridge to mate appropriately to the head with the sealing locations 42, 52 well above the pressure cap.

Inside the interior space of the invented pressure vessel 22 is placed the invented filter cartridge 30. The cartridge 30 comprises a cartridge body 64 and a cartridge cap 66 that connect preferably by a snap connection 68 but may be connected by other means. The connection of cartridge body 64 and cartridge cap 66 preferably includes an o-ring 8 or other liquid-sealing mechanism to prevent liquid from leaking out between the cartridge body and cartridge cap.

The cartridge body 64 is generally cylindrical with a closed bottom and an open top across which the cartridge cap 66 extends. The cartridge cap 66 includes radially-outwardly-protruding tabs 65 that are spaced circumferentially around the bottom region of the cartridge cap 66. The tabs 65 snap into circumferentially-spaced slots 67 near the top of the cartridge body for connecting the body and cap after the cartridge internals and media have

been installed. The top end of the cartridge cap includes cylindrical neck 44 of about half the diameter of the largest diameter of the cap and with adaptation on its outer surface for holding an o-ring at circumference groove 42.

The preferred internals and media of the filter cartridge comprise one or more filter  
5 or treatment media 36, a top media felt pad 82, media separator 182, separator felt pad 282, a central tube ("stem" 84), the inlet tube member 34 connected to stem 84 and having inlet end 33, and o-rings 42', 52', bypass tube 37, o-ring 108 sealing bypass tube 37 to inlet tube member 34, and if bypass system 35 is included, o-ring 108' sealing bypass tube 37 to stem 84, and o-ring 109. If bypass system 35 is excluded, the tube member 34 could be adapted  
10 to seal to stem 84. The central stem 84 lies on radially-formed ribs 86 on the interior bottom wall of the cartridge body 64. Ribs 86 create a fluid path from the inside of stem 84 into media 36. The stem 84 upends from the ribs 86 to extend through the interior space and through the pads, media separators, and media 36 contained therein to seal with the inlet end 33. The media 36 may be any single media or combination of media desired for  
15 liquid/beverage treatment, filtration or conditioning. Media 36 are preferably granular activated carbon and ion exchange resin, and this media choice may be taken into account by one skilled in the art when selecting the supports and pads below, between, and above the various media.

Inside and coaxial with inlet tube member 34 is an optional bypass sleeve 37 with a  
20 lower portion 37' that connects to stem 84 and may optionally have holes, o-rings, or other structure for providing a liquid bypass system. The structure 133 shown at the top of the sleeve 37 and in the top inside view of sleeve 37 in Figures 12 and 13 may cooperate with the dust cap C shown in Figures 3, 4, and 8. Dust cap C may be used to keep the inlet and outlet of the cartridge clean, and, optionally, may cooperate with structure 133 to allow

adjustment of the sleeve 37 to adjust the liquid bypass by rotating the sleeve. As stated above, the liquid bypass is optional and may be closed, blocked off or eliminated.

From a fluid flow point of view, the fluid enters the inlet end 33 (and through the interior of sleeve 37) and flows down into the stem 84, and out through radial ribs 86 in the bottom of cartridge body 64 to the media 136. As mentioned above, a liquid bypass system 5 35 may optionally be incorporated to allow a portion of the liquid to flow only through a portion of the media zones. From the media 136, the liquid flows generally axially upwards through the other media 36, supports and pads, through apertures in the inlet tube base and into the annular space 38 between the inside surface of the cartridge cap 66 and the outside 10 surface of the inlet end 33. Annular space 38 may include ribs 71 running axially in the annular space 38 to stabilize the inlet end 33 relative to the cartridge cap.

As can be seen to best advantage in Figure 3, the cartridge 30 fits closely inside the pressure vessel 22, and the pressure vessel 22 acts as a reinforcing shell around substantially all of the cartridge 30. Unlike many conventional filter cartridges, however, the cartridge 30, 15 particularly neck 44, of the present invention extends at its top end out of the pressure vessel to seal directly to the filter head. The pressure vessel and filter cartridge, therefore, need not liquid seal to each other, although the inventor envisions adequate embodiments that would include sealing between the filter cartridge and pressure vessel. In the preferred embodiment, liquid does not flow or reach between the pressure vessel cap and the cartridge 20 cap, that is, there need be no liquid seal in the general location L where the two caps 46, 66 contact or come near to each other near the aperture 24. Also, the cartridge body 64 need not seal to the inner surface of the pressure vessel body 54, but should be closely adjacent.

The various components of the cartridge 30 are preferably recyclable. Specifically, the cartridge body 64, cap 66, stem 84, spacer 86 are preferably recyclable polyethylene or

polypropylene. The various media 36 are preferably recyclable carbon, resin, or other material. The internal pads and media supports are preferably made of recyclable materials such as polyurethane or polypropylene. The O-rings may not be recyclable, but these are preferably the only components that are not, and they are very small, easily removed and should be removed and discarded to prevent back-contamination with any bacteria or pathogens that might be present on them or on the o-ring lubricating oil.

The absolute wall thickness of the neck 44 is important as it is critical to the filter cartridge and the filter assembly, in general, meeting safety requirements for withstanding water pressure of the system to which they are connected. For example, to withstand a 500 psi test, the polypropylene neck wall thickness  $T$  preferably greater than or equal to .125 inch in thickness, while the filter cartridge body wall preferably only about .060 inches (typically in the range of .050-.070) in thickness. Therefore, the body wall typically is less than about half the thickness of the neck thickness. Other thicknesses may apply for various materials and pressure requirements. The neck preferably is thick-walled from the top 144 of the neck, all the way through the aperture 24 and for a slight distance down into the pressure vessel to neck bottom 244, to prevent rupturing of the neck in the vicinity of the aperture 24. The inlet tube member 34 wall, which also extends up coaxially with the neck wall out of the pressure vessel, does not need to be of a thickness comparable to the neck wall, because the inlet tube is not exposed to a large pressure difference as the neck wall is. The neck wall withstands the full pressure difference between the water in the neck and the outside atmosphere, while the inlet tube has water both inside it (inlet water) and outside it (outlet water) and the pressure difference between the two water streams is only the pressure drop through the filter cartridge.

Therefore, one may describe the preferred invented filter cartridge as having an exterior wall having a high strength portion and a low strength portion. In the preferred embodiment, the exterior wall is the entire outer wall of the filter cartridge including the body and cap. The high strength portion is defined as being adapted to withstand pressure of greater than 475 psi, and is preferably a neck that extends up from one end of the filter cartridge. The low strength portion is defined as being adapted to withstand only minimal pressure, for example less than 10 psi, and is preferably the entirety of the outer wall of the filter cartridge except the above described neck. Also, the term "pressure bearing" in this Description and Claims means positioned and capable of bearing by itself (without significant reinforcement) the pressure of the fluid in the process in which it is being used. The term "non-pressure bearing" means that a part or portion of a structure is not positioned in a place where it will be exposed to significant pressure, that is, not more than a negligible amount, and especially not more than about 10 psi.

One may see from this description and the drawings, that the filter assembly, comprising the filter cartridge and the pressure vessel, may be removed from the head and the recyclable filter cartridge 30 may easily be removed from the pressure vessel by unscrewing or otherwise disconnecting the pressure cap from the pressure body. Then, the cartridge may be recycled after being disassembled as described below, for example. Other mechanisms for easy opening of the filter cartridge may be used, and these are called herein "latch mechanisms" as they allow closing of the filter cartridge after filling of the cartridge body with media, and then allow opening of the filter cartridge without excessive force or destruction of the body or cap after use. In this Description and the Claims, latch does not imply that no cutting or removal of filter cartridge material may be done to unlatch parts of the exterior wall, but preferably only cutting or removal of a tab or other small portion of a

latch is done rather than destruction by impact, sawing, or slicing the body. Preferably, two parts of the low strength portion of the filter cartridge exterior wall are the parts that are “latched” and “unlatched,” at a seam or connection 68, for example. When the preferred cartridge is removed from the preferred pressure vessel, the cartridge takes with it all the surfaces and seals that have contacted liquid on the “filter assembly side” of the process. Thus, potentially contaminated surfaces and o-rings are removed periodically rather than remaining with the reused pressure vessel. Some contamination may reside on the “filter head side” of the process, because the filter head is not recycled or replaced, but the total head surfaces as typically small in area, and, if the o-rings are removed with the filter cartridge, the chances of o-ring lubricant contamination, for example, are minimized.

In order to disassemble the cartridge 30, special adaptation is preferably included to allow separation of the components of the cartridge 30 without crushing or cracking the cartridge. Preferably, the adaptation is such that accidental separation is unlikely, but purposeful separation prior to recycling is easy with the correct tool. Preferably, the adaptation comprises a snap-in tab and slot system, illustrated to best advantage in Figures 12-13, or other separation system for opening the cartridge, preferably without cracking, crushing, or drilling through the cartridge housing. The tabs 65 are typically formed integrally with the cartridge cap 66 near its lower end. The cooperating slots 67 near the upper edge of the cartridge body 64 receive the tabs 65 in snap-fit manner, to semi-permanently connect the cap 66 to the body 64. The outer perimeter of the lower end of the cap 66 includes cut-away portions 69 directly above each tab 65 so that the tab and slot connection may be reached by a tool. When the user of recycler wishes to disassemble the filter cartridge 30, he/she may slide a knife or sharp tool down between the cap 66 and the body 64 directly above the tab and slice downward on the tab to remove enough of the tab to



release the body from the cap. This, or other types of separation, allow a person or equipment to reach inside the cartridge, to remove the internals and the media from the cartridge for recycling of the internals and media as well as the external cap and body components.

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Although this invention has been described above with reference to particular means, materials and embodiments, it is to be understood that the invention is not limited to these disclosed particulars, but extends instead to all equivalents within the scope of the following claims.

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## CLAIMS

5 I claim:

1. A liquid filter cartridge for connection to a filter head, the filter cartridge comprising:  
a cartridge body having an exterior wall having a high strength portion and a low  
strength portion;

10 the high strength portion being adapted to connect to and fluidly communicate to a  
filter head and adapted to withstand internal pressure of greater than 475 psi and the low  
strength portion being adapted to be removably received inside a pressure vessel that does  
not enclose and does not support the high strength portion;

the low strength portion defining and surrounding an interior space containing filter  
15 media; and

the exterior wall comprising a latch that closes the exterior wall around the filter  
media and opens the exterior wall for removal of the filter media.

2. A filter cartridge as in Claim 1 comprising an elongated cartridge body and a  
20 cartridge cap, the cap having a protruding neck having a neck wall and fluid inlet  
passage and a fluid outlet passage within the neck wall, and the neck wall being the  
high strength portion.

3. A filter cartridge as in Claim 2, wherein the neck comprises a plurality of seals adapted to seal to a filter head, including a seal on an outer surface of the neck wall.

5 4. The filter cartridge as in Claim 3, wherein the seals of the neck are the only means for fluid sealing the filter cartridge to the filter head.

10 5. The filter cartridge of Claim 2 wherein the neck wall is greater than or equal to .125 inch and the low strength portion is less than .07 inch.

6. The filter cartridge of Claim 1, wherein the exterior wall is made of plastic.

15 7. The filter cartridge of Claim 1, wherein the exterior wall is separable into at least two parts and the latch releasably connects said parts, wherein the latch comprises a tab on one of said parts that snaps into a slot on another of said parts.

8. The filter cartridge of Claim 7, wherein the latch is released by cutting the tab off of the filter cartridge exterior wall.

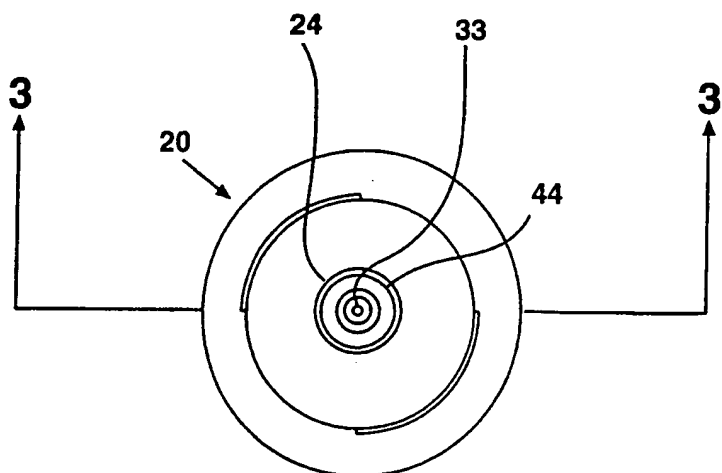
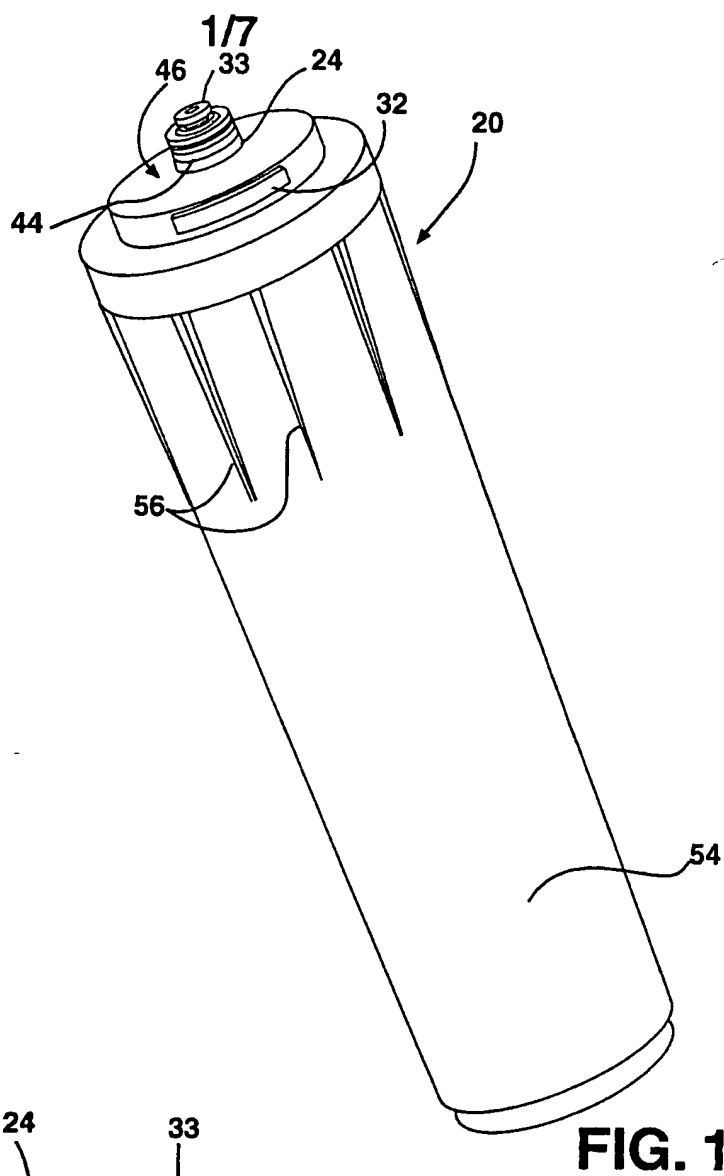
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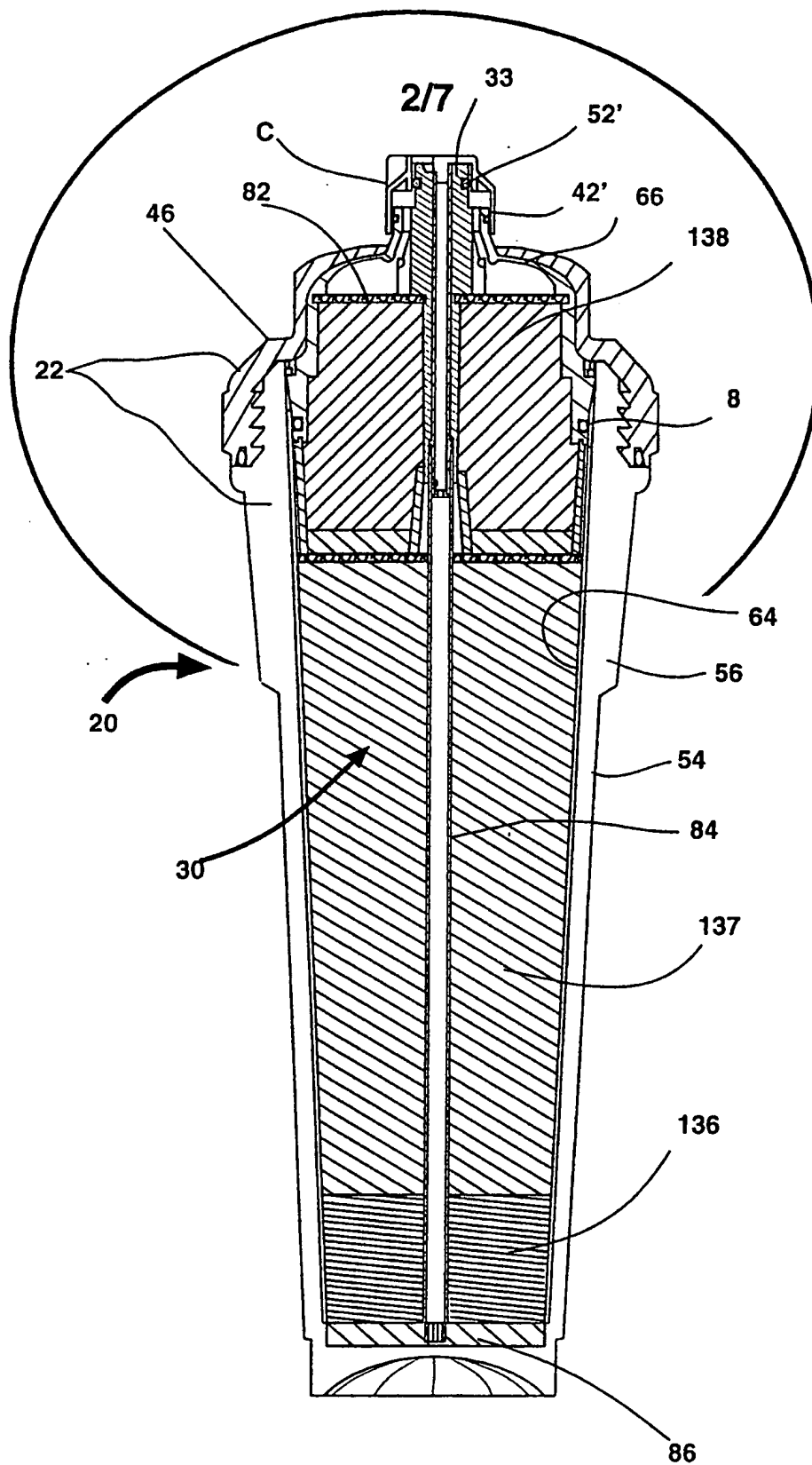
9. A filter assembly for connection to a filter head for receiving fluid from the filter head for filtration, the filter assembly comprising:  
a recyclable filter cartridge containing media, and a pressure vessel;  
the filter cartridge comprising an exterior wall having a pressure-bearing neck  
5 portion adapted to sealably connect to a filter head and a non-pressure bearing portion received inside the pressure vessel;  
wherein the pressure vessel covers the non-pressure bearing portion but does not cover the pressure-bearing neck portion.
- 10 10. A filter assembly as in Claim 9, wherein the neck portion is adapted to seal to the filter head so that fluid from the filter head does not contact the pressure vessel and does not contact the non-pressure bearing portion of the exterior wall.
11. A filter assembly as in Claim 9, wherein the pressure vessel comprised a pressure cap  
15 having an aperture through which the neck portion protrudes for sealing with the filter head.
12. A filter assembly as in Claim 11, further comprising a connection system for  
20 attaching the pressure vessel to the filter head, the connection system located on the pressure vessel and not on the neck.

13. A filter assembly as in Claim 12, wherein the connection system comprises bayonet lugs on the pressure vessel.
- 5 14. A filter assembly as in Claim 9, wherein the pressure vessel does not fluid-seal to the filter cartridge.
- 10 15. A pressure vessel for containing a filter cartridge having a mechanical connection to a filter head without any fluid connection to the filter head.

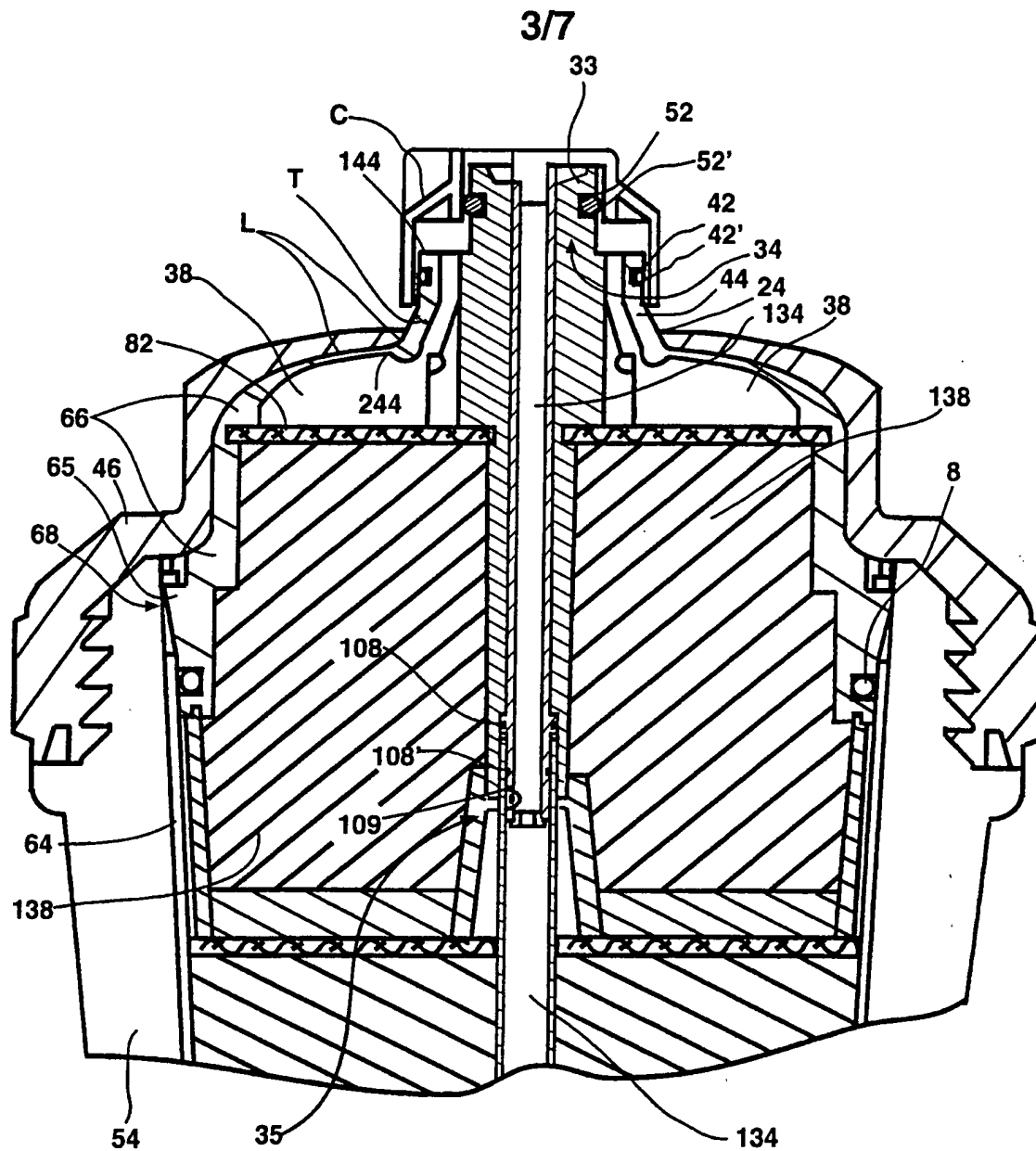
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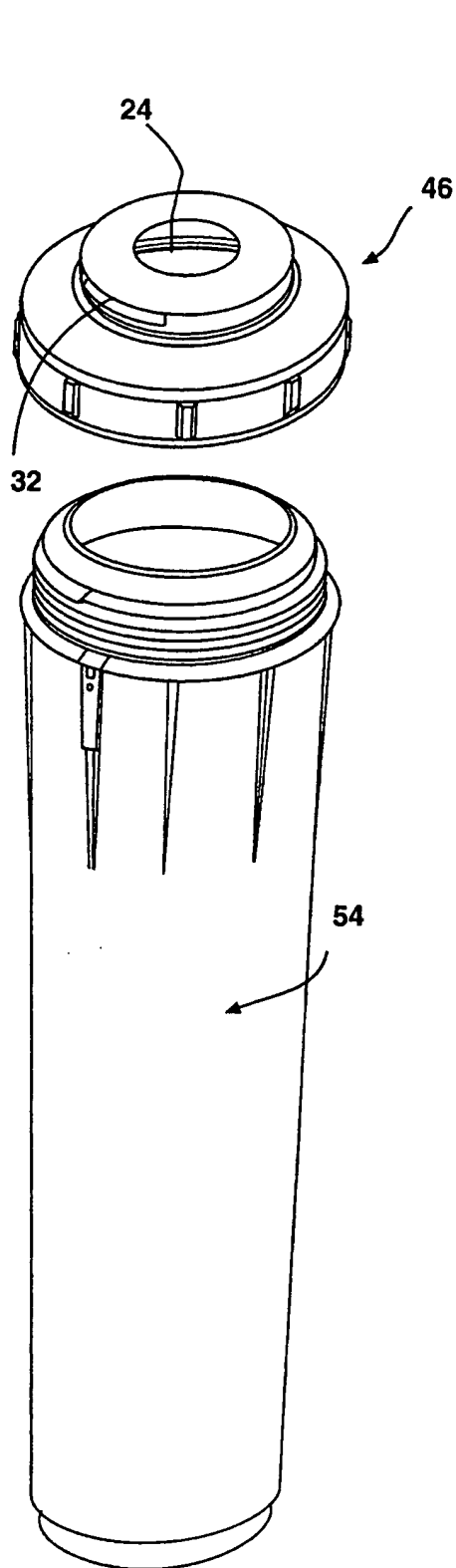


**FIG. 3**

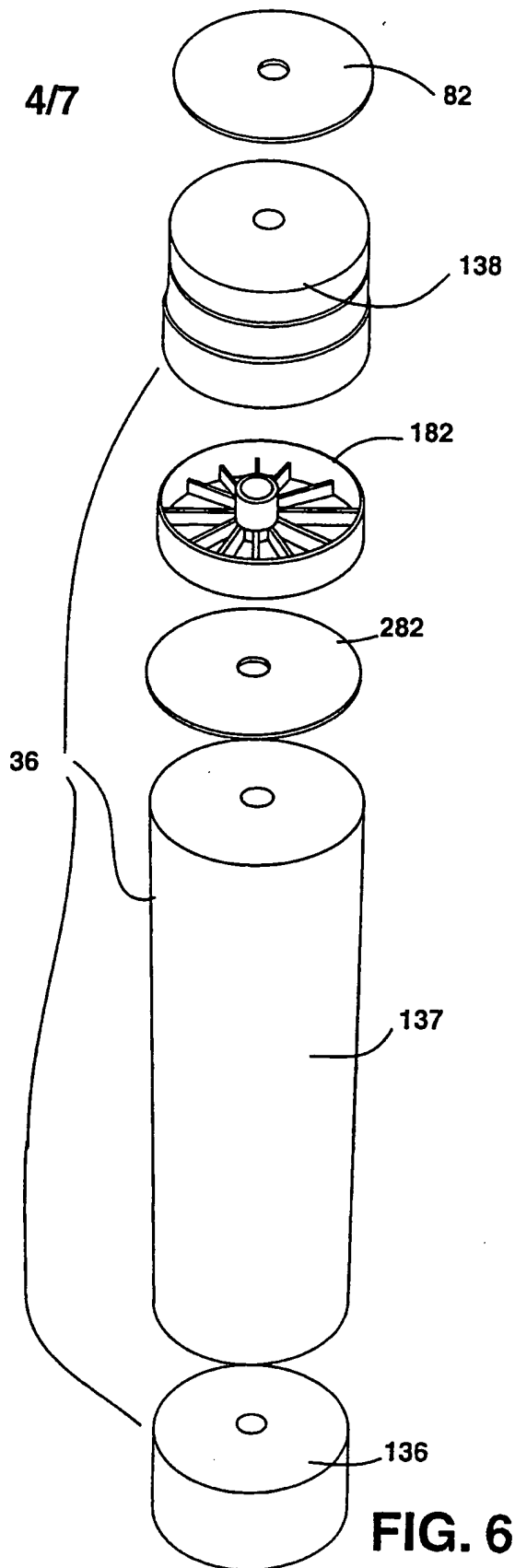


**FIG. 4.**

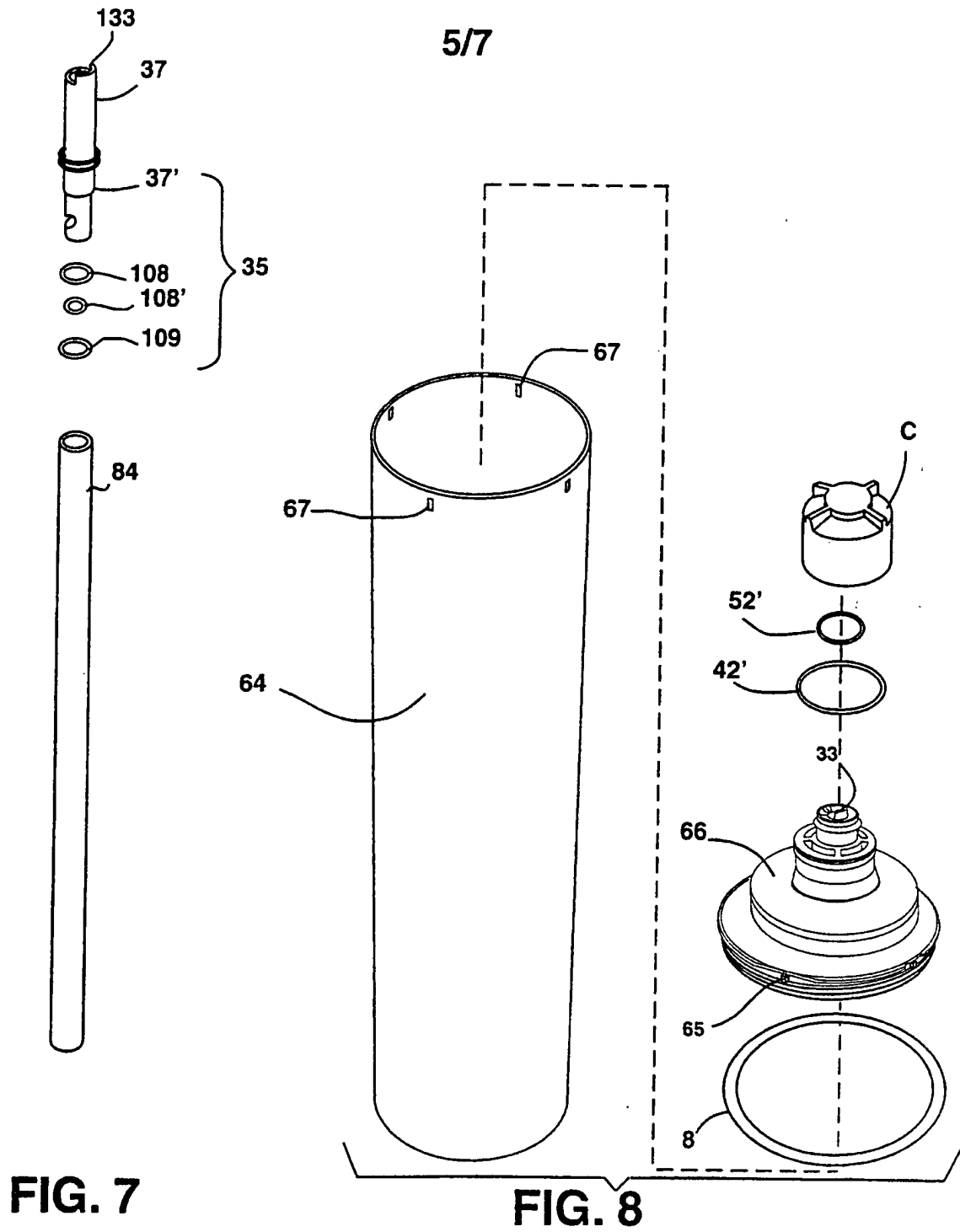




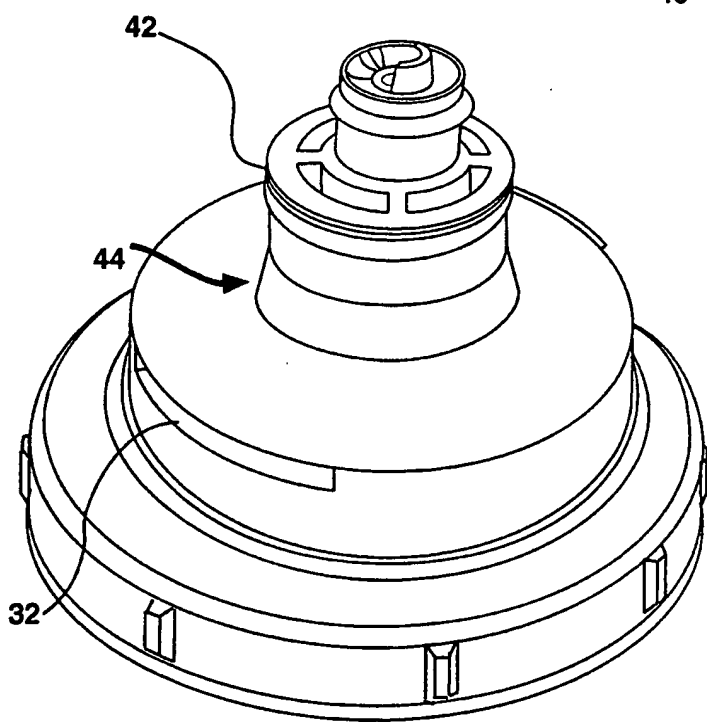
**FIG. 5**



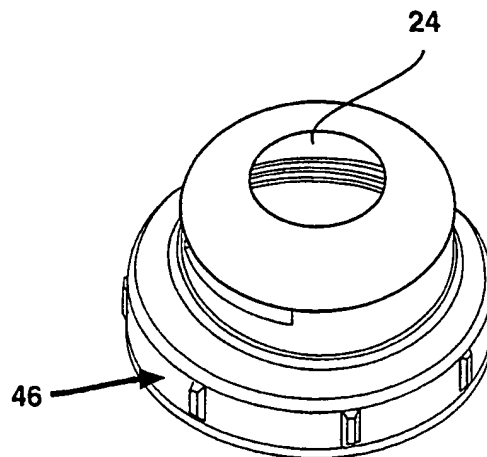
**FIG. 6**



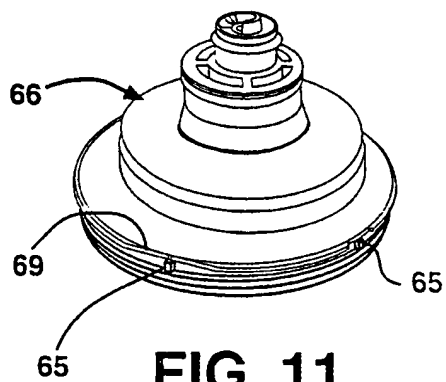
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**FIG. 9**

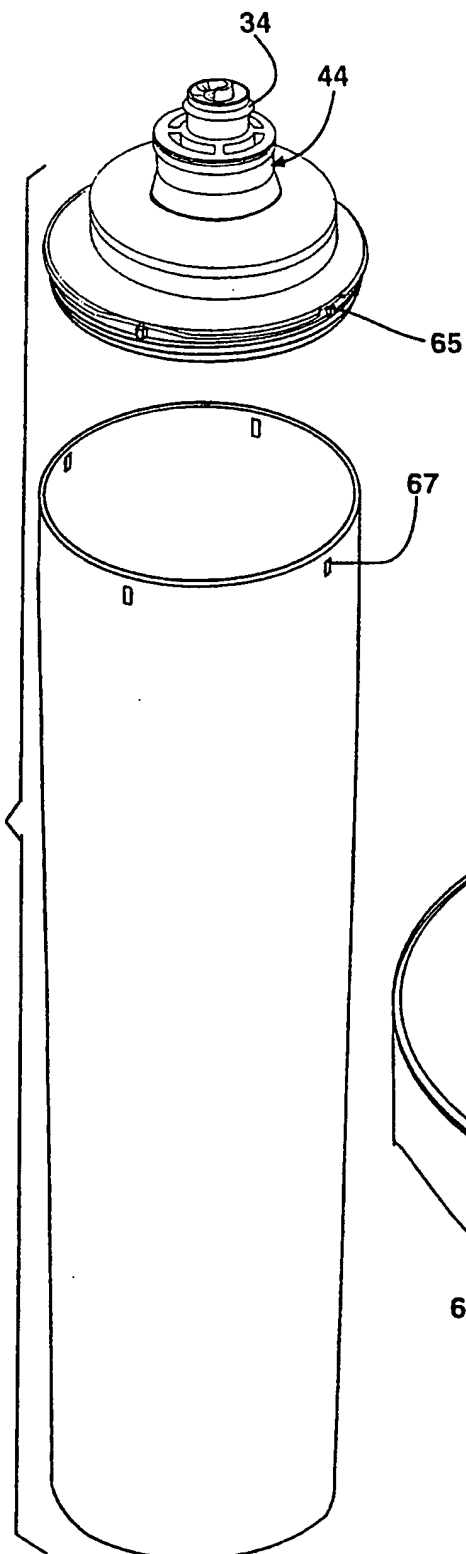


**FIG. 10**

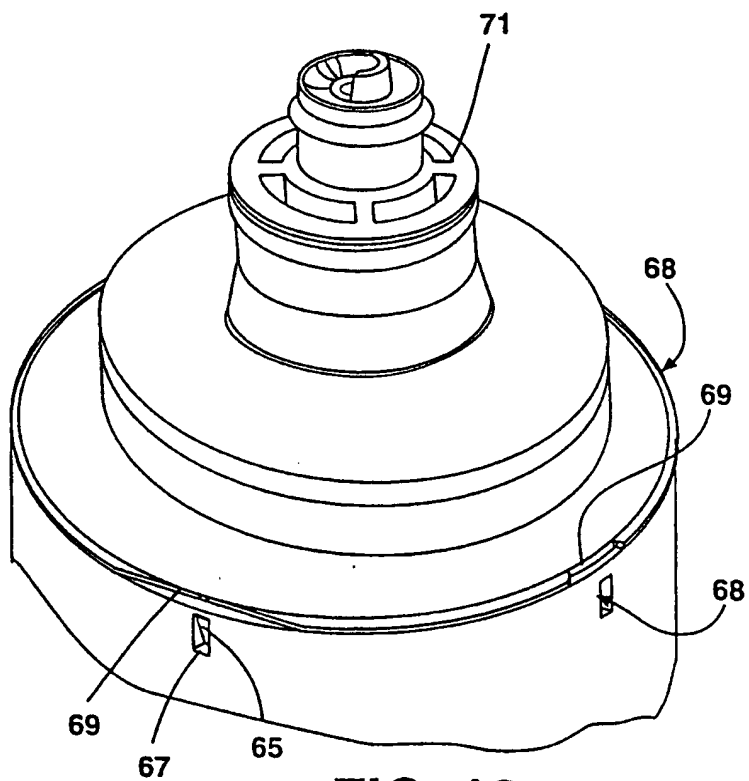


**FIG. 11**

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**FIG. 12**



**FIG. 13**